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Titania nanotubes for energy applications

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Titania (or titanium dioxide) nanotubes are advanced materials with diverse functionalities. They can be synthesized using inexpensive and abundantly available starting material, namely titanium, Ti. A low-cost electrochemical process, utilizing easily available acids and fluoride/chloride-based compounds are used to synthesize the nanotubes. The process is scalable for large-area and large-volume manufacture. The nanotubes may be produced in the form of arrays (either free-standing or attached to Ti) or bundles or even single nanotubes. The tubes maybe prepared with one side closed and the other side open or both sides open (through-hole tubes). The nanotubes have numerous applications in energy. The nanotube array + Ti structure can have direct applications as photoanodes for cost-effective, third generation photovoltaic systems such as sensitized solar cells. Free-standing arrays can be integrated with other flexible substrates for portable photovoltaic device applications (such as in laptops, cellphones, etc.,) and may also be integrated with glass, steel and other materials for automobile/building integrated photovoltaics. Titania is especially attractive for AIPV/BIPV applications because it works well under low light and diffuse light conditions unlike the Si-based solar systems. Upon integration with conducting hole-regenerator polymer materials, the structures will serve as integrated anode+electrolyte systems for fully solid-state solar cells. Nanotube arrays will also find applications as photoanodes for photocatalytic applications such as in the production of hydrogen. Au-nanoparticle attached nanotubes will find applications in catalytic conversion for example conversion of CO to CO_2 that may be used as highly efficient room temperature automobile catalysts. Extensive research has been carried out in the lab to indicate the promise of titania nanotubes for the applications mentioned above. Further research is ongoing to provide stable and highly reliable solid-state solar cells by integrating the nanotube array with polymer/solid electrolyte without loss in overall efficiency; cost-effective solutions to producing titania nanotube-based catalyst/photocatalysts for hydrogen generation and energy conversion.

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